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A Systematic Procedure to Implement the Quantum Protocols for Superluminal Classical Communication and Superluminal Teleportation

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Abstract: This paper discusses a systematic procedure for practically realizing the two new quantum protocols, one for the Superluminal Classical Communication and the other for the Superluminal Teleportation. We describe here how to send the desired sequence of classical bits instantaneously from Alice to Bob and thus practically achieve the Superluminal Classical Communication. Further we describe how this ability for the Superluminal Classical Communication can be used for practically achieving the Superluminal Teleportation of a quantum state from Alice to faraway located Bob by utilizing this ability for Superluminal Classical Communication for superluminally transmitting the two classical bits generated during Alice's measurement of the two qubits in her possession.

Keywords: Entanglement, Inner Product, Superluminal Classical Communication Protocol, Superluminal Quantum Teleportation Protocol

1 Introduction

In [1] two new quantum protocols were sketched, one for superluminal classical communication as a means to exchange classical information in terms of classical bits instantaneously, and the other for achieving the superluminal teleportation by making use of the ability of superluminal classical communication offered by the first protocol. Two classical bits generated with Alice during Alice's partial measurement of the two quantum bits in her possession can be instantaneously transmitted to Bob by making use of the above mentioned quantum protocol for superluminal classical communication. Bob needs them to complete the teleportation protocol. In short, this paper gives a systematic procedure to carry out superluminal classical communication and superluminal teleportation.

Entanglement is what Einstein referred to as "spooky action at a distance." It is a phenomenon by which one particle can effectively "know" something about another particle instantaneously, even if those two particles are separated by great distance. It appears to go against the idea that nothing, not even information, can travel faster than the speed of light. Scientists who study this phenomenon want to be sure that nothing in their experimental setup is somehow creating the illusion of entanglement, perhaps via some physical mechanism or phenomenon that scientists don't yet know about. Being usually fragile to environment, entanglement is robust against conceptual and mathematical tools that struggle with the task of deciphering its rich structure [2].

In an effort to close a possible loophole in entanglement experiments, a group of researchers used starlight as part of their experiment. The researchers have verified that the results of their work are supporting this "spooky" phenomenon. Entanglement has also proved to be a resource of great utility in quantum computation and quantum information which enables one to achieve exponential speedup for solving certain problems. Entanglement is a fundamental resource of nature which is comparable in importance to energy, information, entropy, or any other equally fundamental resource.

Quantum entanglement describes the strong correlation that exists among different parts of composite quantum systems even after the parts of these composite quantum systems may get spacelike separated from one

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another. The so called teleportation of an arbitrary quantum state from one party to other party [3] has been verified experimentally. This quantum teleportation is not only a theoretical idea but has been verified in the teleportation experiments between two locations separated over the distance of the order of hundred kilometers [4,5,6,7,8,9]. Recently a team of Chinese scientists have extended this range to about 1400 kilometers [10].

This paper is organized as follows. In section 2 we describe in steps the procedure for testing the quantum protocol for Superluminal Classical Communication. In section 3 we describe how one can achieve superluminal teleportation by making use of the quantum protocol for Superluminal Classical Communication for superluminally transmitting the required classical bits to Bob to complete the teleportation protocol.

2 A Systematic Procedure for Superluminal Classical Communication:

We now proceed with developing a stepwise procedure for testing the proposed quantum protocol for superluminal classical communication.

As seen in [1], one can define and prepare orthonormal Bell basis containing 2^n Bell basis states for the n-qubit case, namely,$|\beta_{i_1 i_2 \cdots i_n}\rangle, i_1, i_2, \cdots, i_n \in \{0,1\}$ and relate them with the corresponding n-qubit computational basis states, namely, $|i_1 i_2 \cdots i_n\rangle$ such that $i_1, i_2, \cdots, i_n \in \{0,1\}$, through a $2^n \times 2^n$ matrix which is invertible and unitary.

A formula for writing an n-qubit Bell basis state in terms of n-qubit computational basis states is as follows:

$$|\beta_{i_1 i_2 \cdots i_n}\rangle = \frac{1}{\sqrt{2}}(|0 i_2 i_3 \cdots i_n\rangle$$

$$+(-1)^{i_1}|1(1-i_2)(1-i_3)\cdots(1-i_n)\rangle)$$

Using this relation one can easily construct the transformation matrix of size $2^n \times 2^n$ to express n-qubit Bell basis states in terms of corresponding n-qubit computational basis states. One can further see that this matrix is invertible and unitary.

One can easily build the quantum circuit to obtain the n-qubit Bell basis state. By operating this quantum circuit on the computational basis state, $|x_1 x_2 \cdots x_n\rangle$, one will obtain the desired Bell basis state, $|\beta_{x_1 x_2 \cdots x_n}\rangle$.

This quantum circuit can be built by carrying out the following steps:

(a) INPUT: Start with the computational basis state, $|x_1 x_2 \cdots x_n\rangle$.

(b) Operate the Hadamard gate, H, on the first qubit $|x_1\rangle$.

(c) Operate the CNOT gates, $C_{12}, C_{13}, C_{14}, \cdots, C_{1n}$ with the first qubit, namely, $H|x_1\rangle$ as the control qubit and respectively $|x_2\rangle, |x_3\rangle, |x_4\rangle, \cdots, |x_n\rangle$ as the target qubits.

(d) OUTPUT: One arrives at the desired Bell basis state, $|\beta_{x_1 x_2 \cdots x_n}\rangle$.

It is interesting to note that the computational basis state, $|x_1 x_2 \cdots x_n\rangle$, is a separable state while the Bell basis state, $|\beta_{x_1 x_2 \cdots x_n}\rangle$, is an entangled state, in fact a maximally entangled state.

We will setup below a procedure to manage Superluminal Classical Communication between two participants, Alice and Bob. To achieve Superluminal Classical Communication we need to prepare certain quantum states which are needed for this protocol.

Let us proceed in the following steps:

Step 1: Initially when Alice and Bob are together in a laboratory they will prepare several copies of the following quantum states:

(i)

$$|\alpha_{11}\rangle = |\beta_{0 j_1 j_2 \cdots j_u}\rangle$$

where first qubit of each of the copy of these "Generalized" Bell basis states, $|\alpha_{11}\rangle$, is kept with Alice, and the group of next u qubits $j_1, j_2, \cdots, j_u$ in each of the copy is kept in the possession of Bob.

(ii)

$$|\alpha_{12}\rangle = |\beta_{0 j_1 j_2 \cdots j_u}\rangle$$

where first qubit of each of the copy of these "Generalized" Bell basis states, $|\alpha_{12}\rangle$, is kept with Bob, and the group of next u qubits $j_1, j_2, \cdots, j_u$ in each of that copy is kept in the possession of Alice.

(iii)

$$|\alpha_{21}\rangle = |\beta_{0 k_1 k_2 \cdots k_v}\rangle$$

where as above the first qubit of each of the copy of these "Generalized" Bell basis states, $|\alpha_{21}\rangle$, is with Alice, and the group of next v qubits $k_1, k_2, \cdots, k_v$ in each of that copy is kept in the possession of Bob.

(iv)

$$|\alpha_{22}\rangle = |\beta_{0 k_1 k_2 \cdots k_v}\rangle$$

where as above the first qubit of each of the copy of these "Generalized" Bell basis states, $|\alpha_{22}\rangle$, is with Bob, and the group of next v qubits $k_1, k_2, \cdots, k_v$ in each of that copy is kept in the possession of Alice.

Convention: We have chosen these sequences "$j_1 j_2 \cdots j_u$" and "$(1-k_1)(1-k_2)\cdots(1-k_v)$" such that their arrangements of bit-values correspond to the following specific meaning in the English language: We have chosen these sequences such that the sequence "$j_1 j_2 \cdots j_u$" stands for the information, "BLUE SKY", and the sequence "$(1-k_1)(1-k_2)\cdots(1-k_v)$" stands for the information, "BRIGHT SUN". Clearly, sequence $(1-j_1)(1-j_2)\cdots(1-j_u)$ then conveys the information "COMPLEMENT of BLUE SKY" and sequence "$(k_1 k_2 \cdots k_v)$" then conveys the information "COMPLEMENT of BRIGHT SUN". Note that the above complements, namely, "COMPLEMENT of BLUE SKY" and "COMPLEMENT of BRIGHT SUN" may not be forming meaningful arrangements of bit-values as far as their linguistic meaning is concerned but it is easy to see that if one will apply NOT gate on these sequences of

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bit values corresponding to the "COMPLEMENT of BLUE SKY" and "COMPLEMENT of BRIGHT SUN" one will recover the meaningful arrangements of bit-values corresponding to "BLUE SKY" and "BRIGHT SUN" respectively.

The above convention is setup and informed to both Alice and Bob when they were together initially.

Thus, by performing actions depicted in (i)-(iv) we have ensured to have ample stock of the above states with Alice and Bob.

Step 2: Further, when initially together in the same laboratory, Alice and Bob prepare several copies of the following quantum states:

(v)

$$|\mu_{11}\rangle = |0 j_1 j_2 \cdots j_u\rangle$$

where first qubit of each of the copy of these computational basis states, $|\mu_{11}\rangle$, is with Alice, and the group of next u qubits represented above as $j_1 j_2 \cdots j_u$ in each of that copy is in the possession of Bob.

(vi)

$$|\mu_{12}\rangle = |1(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$$

where first qubit of each of the copy of these computational basis states, $|\mu_{12}\rangle$, is with Alice, and the group of next u qubits represented above as $(1-j_1)(1-j_2)\cdots(1-j_u)$ in each of that copy is in the possession of Bob.

(vii)

$$|\mu_{21}\rangle = |0 j_1 j_2 \cdots j_u\rangle$$

where as above the first qubit of each of the copy of these computational basis states, $|\mu_{21}\rangle$, is with Bob, and the group of next u qubits represented above as $j_1 j_2 \cdots j_u$ in each of that copy is in the possession of Alice.

(viii)

$$|\mu_{22}\rangle = |1(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$$

where as above the first qubit of each of the copy of these computational basis states, $|\mu_{22}\rangle$, is with Bob, and the group of next u qubits represented above as $(1-j_1)(1-j_2)\cdots(1-j_u)$ in each of that copy is in the possession of Alice.

Step 3: Also further, when initially together in the same laboratory, Alice and Bob prepare several copies of the following quantum states:

(ix)

$$|\nu_{11}\rangle = |0 k_1 k_2 \cdots k_v\rangle$$

where as above the first qubit of each of the copy of these computational basis states, $|\nu_{11}\rangle$, is with Alice, and the group of next v qubits represented above as $k_1 k_2 \cdots k_v$ in each of that copy is in the possession of Bob.

(x)

$$|\nu_{12}\rangle = |1(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$$

where as above the first qubit of each of the copy of these computational basis states, $|\nu_{12}\rangle$, is with Alice, and the group of next v qubits represented above as $(1-k_1)(1-k_2)\cdots(1-k_v)$ in each of that copy is in the possession of Bob.

(xi)

$$|\nu_{21}\rangle = |0 k_1 k_2 \cdots k_v\rangle$$

where as above the first qubit of each of the copy of these computational basis states, $|\nu_{11}\rangle$, is with Bob, and the group of next v qubits represented above as $k_1 k_2 \cdots k_v$ in each of that copy is in the possession of Alice.

(xii)

$$|\nu_{22}\rangle = |1(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$$

where as above the first qubit of each of the copy of these computational basis states, $|\nu_{12}\rangle$, is with Bob, and the group of next v qubits represented above as $(1-k_1)(1-k_2)\cdots(1-k_v)$ in each of that copy is in the possession of Alice.

After completing these three steps Alice and Bob go away from each other and separate from each other by a distance of astronomical order.

Step 4: Alice is then provided with the classical information in terms of a sequence of classical bits $s_1, s_2, \cdots, s_m$ where $s_i \in \{0,1\}$ for all $i \in \{1,2,\cdots,m\}$. This sequence of classical bits is to be transmitted bit by bit to the now faraway recipient Bob in the same order as given, i.e. firstly the classical bit, s_1, is to be transmitted superluminally to Bob. After the successful superluminal transmission of the classical bit s_1 Alice will then proceed to superluminally transmit the classical bit s_2 to Bob, and so on, till finally Alice will successfully transmit s_m to Bob instantaneously, i.e. with superluminal speed, as is done for other classical bits.

Step 5: Alice now reads the first entry of the sequence of classical bits, namely, s_1. Note that there are two possible values for s_1, $s_1 = 0$ and $s_1 = 1$. We now proceed with considering the following four cases:

Case 1: Alice wants to covey to Bob that $s_1 = 0$. In this case Alice measures partially the state $|\alpha_{11}\rangle$ among the several copies available to her in the computational basis. As a result of this measurement the state $|\alpha_{11}\rangle$ will collapse either into state

$$|\mu_{11}\rangle = |0 j_1 j_2 \cdots j_u\rangle$$

or into state

$$|\mu_{12}\rangle = |1(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$$

As a consequence of this partial measurement by Alice in the computational basis she will find the single qubit in her possession to be collapsed into either $|0\rangle$ or $|1\rangle$ state and correspondingly Bob's state of u qubits in his possession will collapse into either $|j_1 j_2 \cdots j_u\rangle$ or $|(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$ which conveys the information "BLUE SKY" or the "COMPLEMENT of BLUE SKY" to Bob and it is already told to Bob (as per the above convention, made when Alice and Bob were

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together) that the information "BLUE SKY" or the "COMPLEMENT of BLUE SKY" corresponds to $s_1 = 0$.

The COMPLEMENT may correspond by chance to some meaningful arrangement of English letters or it could be some meaningless arrangement of letters in the English language but note that by applying NOT gate on the "COMPLEMENT of BLUE SKY" one can easily recover "BLUE SKY".

Note that we have made a convention that whatever outcome we may get, namely, "BLUE SKY" or the "COMPLEMENT of BLUE SKY" we have decided a priory that such outcome corresponds to $s_1 = 0$. Thus Alice can manage to convey to Bob that $s_1 = 0$ by partially measuring in the computational basis a copy of the state $|\alpha_{11}\rangle$ among the sufficiently many copies available to her.

But the important point is that we need to provide some means to Bob so that he will know (recognize) that Alice wants to communicate that $s_1 = 0$ and so has partially measured the state $|\alpha_{11}\rangle$.

How to achieve this? For achieving this we actually do the following:

We ask Alice to partially measure the copies of the state $|\alpha_{11}\rangle$ shared by her with Bob sufficiently many times and we ask Bob to find the value of the inner product [11] $||\langle\mu_{11}|\alpha_{11}\rangle||$ sufficiently many times.

By measuring the state $|\alpha_{11}\rangle$ sufficiently many times Alice will find that in 50 percent of the cases the state $|\alpha_{11}\rangle$ will collapse into state $|\mu_{11}\rangle = |0j_1j_2\cdots j_u\rangle$ and for the other 50 percent of cases it will collapse into state $|\mu_{12}\rangle = |1(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$, therefore, in the 50 percent of the cases the value of inner product $\langle\mu_{11}|\alpha_{11}\rangle = 1$, and in about other 50 percent of the cases the value of inner product $\langle\mu_{11}|\alpha_{11}\rangle = 0$.

If Alice had not partially measured the state $|\alpha_{11}\rangle$ then the value of inner product will be always equal to one, i.e. $\langle\mu_{11}|\alpha_{11}\rangle = 1$ in 100 percent of cases. This is so because the part $|\mu_{11}\rangle = |0j_1j_2\cdots j_u\rangle$ will always be present in the unmeasured $|\alpha_{11}\rangle$ state which will always make the value of the inner product, $||\langle\mu_{11}|\alpha_{11}\rangle||$, equal to unity.

From this "always" equal to unit value of the inner product, $||\langle\mu_{11}|\alpha_{11}\rangle||$, found by Bob he understands that Alice has not measured the state $|\alpha_{11}\rangle$ implying for him that $s_1 \neq 0$, i.e. Alice does not want to convey that $s_1 = 0$.

Case 2: Alice wants to covey to Bob that $s_1 = 1$. In this case Alice measures partially the state $|\alpha_{21}\rangle$ among the several copies available to her in the computational basis. As a result of this measurement the state $|\alpha_{21}\rangle$ will collapse either into state

$$|\nu_{11}\rangle = |0k_1k_2\cdots k_v\rangle$$

or into state

$$|\nu_{12}\rangle = |1(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$$

As a consequence of this partial measurement by Alice in the computational basis she will find the single qubit in her possession to be collapsed into either $|0\rangle$ or $|1\rangle$ state and correspondingly Bob's state of v qubits in his possession will collapse into either $|k_1k_2\cdots k_v\rangle$ or $|(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$ which conveys the information "COMPLEMENT of BRIGHT SUN" or the "BRIGHT SUN" to Bob and it is already told to Bob (above convention, when Alice and Bob were together) that the information "COMPLEMENT of BRIGHT SUN" or the "BRIGHT SUN" corresponds to $s_1 = 1$.

The COMPLEMENT may corresponds by chance some meaningful arrangement of English letters or it could be be some meaningless arrangement of letters in the English language but note that by applying NOT gate on the "COMPLEMENT of BRIGHT SUN" one can easily recover "BRIGHT SUN".

Note that we have made a convention that whatever outcome we may get, namely, "COMPLEMENT of BRIGHT SUN" or the "BRIGHT SUN" we have decided a priory that such outcome corresponds to $s_1 = 1$. Thus Alice can manage to convey to Bob that $s_1 = 1$ by partially measuring in the computational basis a copy of the state $|\alpha_{21}\rangle$ among the sufficiently many copies available to her.

But the important point is that we need to provide some means to Bob so that he will know (recognize) that Alice wants to communicate that $s_1 = 1$ and so has partially measured the state $|\alpha_{21}\rangle$.

How to achieve this? For achieving this we actually do the following:

We ask Alice to partially measure the copies of the state $|\alpha_{21}\rangle$ shared by her with Bob sufficiently many times and we ask Bob to find the value of the inner product [11] $||\langle\nu_{11}|\alpha_{21}\rangle||$ sufficiently many times.

By measuring the state $|\alpha_{21}\rangle$ sufficiently many times Alice will find that in 50 percent of the cases the state $|\alpha_{21}\rangle$ will collapse into state $|\nu_{11}\rangle = |0k_1k_2\cdots k_v\rangle$ and for the other 50 percent of cases it will collapse into state $|\nu_{12}\rangle = |1(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$, therefore, in the 50 percent of the cases the value of inner product $\langle\nu_{11}|\alpha_{21}\rangle = 1$, and in about other 50 percent of the cases the value of inner product $\langle\nu_{11}|\alpha_{21}\rangle = 0$.

If Alice had not partially measured the state $|\alpha_{21}\rangle$ then the value of inner product will be always equal to one, i.e. $\langle\nu_{11}|\alpha_{21}\rangle = 1$ in 100 percent of cases. This is so because the part $|\nu_{11}\rangle = |0k_1k_2\cdots k_v\rangle$ will be always present in the unmeasured $|\alpha_{21}\rangle$ state which will always make the value of the inner product, $||\langle\nu_{11}|\alpha_{21}\rangle||$, equal to unity.

From this "always" equal to unit value of the inner product, $||\langle\nu_{11}|\alpha_{21}\rangle||$, found by Bob he understands that Alice has not measured the state $|\alpha_{21}\rangle$ implying for him that $s_1 \neq 1$, i.e. Alice does not want to convey that $s_1 = 1$.

What Alice has done so far?

Note that in the sequence given to Alice for transmitting to Bob s_1 had a definite value, i.e. either $s_1 = 0$ or $s_1 = 1$ and not both. Therefore, Alice will rightly measure sufficiently many times the copies of the state $|\alpha_{11}\rangle$ shared by her with Bob when $s_1 = 0$ and also will rightly measure sufficiently many times the copies of

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the state $|\alpha_{21}\rangle$ shared by her with Bob when $s_1 = 1$ and will thus transmit the correct value of s_1 to Bob.

Now, notice that what Alice has done so far is only one thing: (i) Alice continued measuring, one after the other, the state $|\alpha_{11}\rangle$, when $s_1 = 0$ and (ii) and continued measuring, one after the other, the state $|\alpha_{21}\rangle$, when $s_1 = 1$, as she is asked to do so for sufficiently many times. But what do one meant by sufficiently many times? Sufficiently many times to us meant those many times till she understands that the correct value of s_1 has been successfully transmitted to Bob. This is only possible when she will receive a message from Bob that he has received the correct value of s_1 and such message should reach to Alice again with superluminal speed. How to achieve such task? For achieving such task:

What Bob has to do now?

Case 3: Bob has found that $s_1 = 0$ and wants to convey this back to Alice.

In this case Bob measures partially the state $|\alpha_{12}\rangle$ among the several copies available to him in the computational basis. As a result of this measurement the state $|\alpha_{12}\rangle$ will collapse either into state

$$|\mu_{21}\rangle = |0 j_1 j_2 \cdots j_u\rangle$$

or into state

$$|\mu_{22}\rangle = |1(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$$

As a consequence of this partial measurement by Bob in the computational basis he will find the single qubit in his possession to be collapsed into either $|0\rangle$ or $|1\rangle$ state and correspondingly Alice's state of u qubits in her possession will collapse into either $|j_1 j_2 \cdots j_u\rangle$ or $|(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$ which conveys the information "BLUE SKY" or the "COMPLEMENT of BLUE SKY" to now Alice and it is already told to Alice (above convention, when Alice and Bob were together) that the information "BLUE SKY" or the "COMPLEMENT of BLUE SKY" corresponds to $s_1 = 0$.

The COMPLEMENT may corresponds by chance some meaningful arrangement of English letters or it could be be some meaningless arrangement of letters in the English language but note that by applying NOT gate on the "COMPLEMENT of BLUE SKY" one can easily recover "BLUE SKY".

Note that we have made a convention that whatever outcome we may get, namely, "BLUE SKY" or the "COMPLEMENT of BLUE SKY" we have decided a priory that such outcome corresponds to $s_1 = 0$. Thus Bob can manage to convey to Alice that $s_1 = 0$ by partially measuring in the computational basis a copy of the state $|\alpha_{12}\rangle$ among the sufficiently many copies available to him.

But the important point is that we need to provide some means to Alice so that she will know (recognize) that Bob wants to communicate back that he has received $s_1 = 0$ and so has partially measured the state $|\alpha_{21}\rangle$.

How to achieve this? For achieving this one actually does the following:

We now ask Bob to partially measure the copies of the state $|\alpha_{12}\rangle$ shared by him with Alice sufficiently many times and we ask Alice to find the value of the inner product [11] $||\langle\mu_{21}|\alpha_{12}\rangle||$ sufficiently many times.

By measuring the state $|\alpha_{12}\rangle$ sufficiently many times Bob will find that in 50 percent of the cases the state $|\alpha_{21}\rangle$ will collapse into state $|\mu_{21}\rangle = |0 j_1 j_2 \cdots j_u\rangle$ and for the other 50 percent of cases it will collapse into state $|\mu_{22}\rangle = |1(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$, therefore, in the 50 percent of the cases the value of inner product $\langle\mu_{21}|\alpha_{21}\rangle = 1$, and in about other 50 percent of the cases the value of inner product $\langle\mu_{21}|\alpha_{12}\rangle = 0$.

If Bob had not partially measured the state $|\alpha_{21}\rangle$ then the value of inner product will be always equal to one, i.e. $\langle\mu_{21}|\alpha_{12}\rangle = 1$ in 100 percent of cases. This is so because the part $|\mu_{21}\rangle = |0 j_1 j_2 \cdots j_u\rangle$ will always be present in the unmeasured $|\alpha_{21}\rangle$ state which will always make the value of the inner product, $||\langle\mu_{21}|\alpha_{12}\rangle||$, equal to unity.

From this "always" equal to unit value of the inner product, $||\langle\mu_{21}|\alpha_{12}\rangle||$, found by Alice she understands that Bob has not measured the state $|\alpha_{21}\rangle$ implying for her that the correct value of s_1 has not yet reached to Bob.

Case 4: Bob has found that $s_1 = 1$ and wants to convey this back to Alice.

In this case Bob measures partially the state $|\alpha_{22}\rangle$ among the several copies available to him in the computational basis. As a result of this measurement the state $|\alpha_{22}\rangle$ will collapse either into state

$$|\nu_{21}\rangle = |0 k_1 k_2 \cdots k_v\rangle$$

or into state

$$|\nu_{22}\rangle = |1(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$$

As a consequence of this partial measurement by Bob in the computational basis he will find the single qubit in his possession to be collapsed into either $|0\rangle$ or $|1\rangle$ state and correspondingly Alice's state of v qubits in her possession will collapse into either $|k_1 k_2 \cdots k_v\rangle$ or $|(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$ which conveys the information "COMPLEMENT of BRIGHT SUN" or the "BRIGHT SUN" to Alice and it is already told to Alice (above convention, when Alice and Bob were together) that the information "COMPLEMENT of BRIGHT SUN" or the "BRIGHT SUN" corresponds to $s_1 = 1$.

The COMPLEMENT may corresponds by chance some meaningful arrangement of English letters or it could be be some meaningless arrangement of letters in the English language but note that by applying NOT gate on the "COMPLEMENT of BRIGHT SUN" one can easily recover "BRIGHT SUN".

Note that we have made a convention that whatever outcome we may get, namely, "COMPLEMENT of BRIGHT SUN" or the "BRIGHT SUN" we have decided a priory that such outcome corresponds to $s_1 = 1$. Thus Bob can manage to convey to Alice that $s_1 = 1$ by

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partially measuring in the computational basis a copy of the state $|\alpha_{22}\rangle$ among the sufficiently many copies available to him.

But the important point is that we need to provide some means to Alice so that she will know (recognize) that Bob wants to communicate that $s_1 = 1$ and so has partially measured the state $|\alpha_{22}\rangle$.

How to achieve this? For achieving this we actually do the following:

We ask Bob to partially measure the copies of the state $|\alpha_{22}\rangle$ shared by him with Alice sufficiently many times and we ask Alice to find the value of the inner product [11] $||\langle\nu_{21}|\alpha_{22}\rangle||$ sufficiently many times.

By measuring the state $|\alpha_{22}\rangle$ sufficiently many times Bob will find that in 50 percent of the cases the state $|\alpha_{22}\rangle$ will collapse into state $|\nu_{21}\rangle = |0k_1k_2\cdots k_v\rangle$ and for the other 50 percent of cases it will collapse into state $|\nu_{22}\rangle = |1(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$, therefore, in the 50 percent of the cases the value of inner product $\langle\nu_{21}|\alpha_{22}\rangle = 1$, and in about other 50 percent of the cases the value of inner product $\langle\nu_{21}|\alpha_{22}\rangle = 0$.

If Bob had not partially measured the state $|\alpha_{22}\rangle$ then the value of inner product will be always equal to one, i.e. $\langle\nu_{21}|\alpha_{22}\rangle = 1$ in 100 percent of cases. This is so because the part $|\nu_{21}\rangle = |0k_1k_2\cdots k_v\rangle$ will be always present in the unmeasured $|\alpha_{22}\rangle$ state which will always make the value of the inner product, $||\langle\nu_{21}|\alpha_{22}\rangle||$, equal to unity.

From this "always" equal to unit value of the inner product, $||\langle\nu_{21}|\alpha_{22}\rangle||$, found by Alice she understands that Bob has not measured the state $|\alpha_{22}\rangle$ implying for her that correct value of s_1 has not yet reached to Bob.

By repeating these actions Alice will be able to transmit $s_2, s_3, \cdots, s_m$ where $s_i \in \{0,1\}$, and thus the entire sequence can be transmitted, bit by bit, from Alice to Bob situated at great distance from Alice and each time Alice will get a confirmation message from Bob about what Alice has just sent to Bob and this all with superluminal speed.

Remark 2.1: In this section we have seen how classical information can be exchanged with superluminal speed between two parties. We have seen how Alice can send the classical bits with him to Bob with superluminal speed. This procedure can be extended to achieve superluminal communication among more number of people as is sketched in section 3 of [1].

3 A Quantum Protocol for Superluminal Teleportation:

The quantum teleportation protocol [3] involves two parties, Alice and Bob. Alice starts with a single qubit quantum state, $|\psi\rangle = a|0\rangle + b|1\rangle$, in her possession which is unknown to her except that $|a|^2 + |b|^2 = 1$. Alice and Bob also start out by sharing between them a Bell state, $|\beta_{00}\rangle = \frac{1}{\sqrt{2}}[|00\rangle + |11\rangle]$ such that the first qubit of this Bell state is in the possession of Alice and the second qubit of this Bell state is with Bob. Suppose that Alice wants to teleport the single qubit state $|\psi\rangle$ in her possession to Bob. The joint state of three qubits is

$$|\Gamma_1\rangle = |\psi\rangle|\beta_{00}\rangle = \frac{1}{\sqrt{2}}[a|000\rangle + a|011\rangle + b|100\rangle + b|111\rangle].$$

Now, if Alice will operate the CNOT gate using the first qubit of $|\Gamma_1\rangle$ as the control qubit and the second qubit of $|\Gamma_1\rangle$ as the target qubit the state $|\Gamma_1\rangle$ changes to

$$|\Gamma_2\rangle = \frac{1}{\sqrt{2}}[a|000\rangle + a|011\rangle + b|110\rangle + b|101\rangle].$$

If Alice now will send the first qubit of the above state, $|\Gamma_2\rangle$ through the Hadamard gate the state $|\Gamma_2\rangle$ changes to

$$|\Gamma_3\rangle = \frac{1}{2}[|00\rangle(a|0\rangle + b|1\rangle) + |01\rangle(a|1\rangle + b|0\rangle)$$

$$+|10\rangle(a|0\rangle - b|1\rangle) + |11\rangle(a|1\rangle - b|0\rangle)].$$

It is easy to check further that the above equation can be rewritten as follows:

$$|\Gamma_3\rangle = \frac{1}{2}[|00\rangle(I|\psi\rangle) + |01\rangle(X|\psi\rangle)$$

$$+|10\rangle(Z|\psi\rangle) + |11\rangle(Z.X|\psi\rangle)],$$

where I, X, Z are standard Pauli operators.

Now, if Alice will perform the partial measurement on the two the two qubits in her possession in the computational basis then any one out of the four computational basis states $|00\rangle, |01\rangle, |10\rangle, |11\rangle$ will be the outcome of such measurement with equal probability equal to $\frac{1}{4}$. After this partial measurement by Alice yielding one out of the four computational basis states and what the posteriory state (third qubit) Bob will have will depend on the outcome of Alice's computational basis measurement. So, the next step of the well known protocol [3] is to convey the result of the partial measurement done of two qubits in her possession in computational basis by Alice to Bob in terms of two classical bits over a classical channel so that Bob can perform the appropriate recovery operation for yielding the exactly identical copy of $|\psi\rangle$ as his qubit (third qubit). This requirement of communicating the result of of the partial measurement by Alice in terms of two classical bits over a classical channel can be done at most with the speed of light since the speed light forms the upper limit for all classical communication. Therefore, without the new methodology in terms of the quantum protocol for instantaneously transmitting the classical information, which we have developed in section 3 above conveying the result of the computational basis measurement in terms of two classical bits from Alice to Bob over a classical channel cannot be done faster than the velocity of light which is the well-known experimentally verified upper limit to the velocity in the universe.

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In order to manage the above said classical communication in terms of two classical bits say s_1, s_2, generated as a result of the partial measurement done by Alice, instantaneously, the protocol given above will be used to superluminally transmitting the classical bits, s_1, s_2 to Bob that have appeared during the partial measurement of the qubits in her possession in Γ_3 by Alice in the computational basis. Using the classical bits, s_1, s_2 received instantaneously from Alice Bob will manage to change the (third) qubit in his possession into the desired quantum state, $|\psi\rangle$, by performing the required appropriate operation. The desired state, $|\psi\rangle$, which was initially with Alice and got destroyed during her partial measurement, will thus be made to reincarnate after instantaneously receiving the classical bits, s_1, s_2 using the above new quantum protocol for superluminal classical communication, through appropriate operation by Bob on his qubit decided by s_1, s_2.

4 Conclusion

The ideas developed in section 2 provides a new technique for instantaneously transmitting any piece of newly generated classical information to faraway located Bob. The outcome of this protocol is not only very important and useful but also very strange and shocking. This is so because in this protocol what information is to be sent to faraway Bob is not known a priory. Alice can send any information generated long after Bob got separated from her. Alice can send any new information to faraway located Bob with superluminal speed that will come into existence in future at her place. The other important application of this new quantum protocol for superluminally communicating any desired classical information in terms of classical bits is in achieving superluminal teleportation of a quantum state from Alice to Bob as is seen above in section 3.

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